

REMARKS

Responsive to the outstanding Office Action, applicant has carefully studied the Examiner's rejections. The claims pending in this application are claims 10-21. Favorable reconsideration of the application in light of the following detailed arguments is respectfully requested.

REJECTION OF CLAIMS UNDER 35 USC §103

In the outstanding Office Action, the Examiner rejected claims 10-21 under 35 USC §103 as being unpatentable over WO 96/33150 in view of US 4,739,124 to Ward. The Examiner states that the WO reference discloses a process for converting alkanes to alkenes comprising contacting the alkane with a dehydrogenation catalyst under conditions sufficient to produce alkene and hydrogen, contacting the effluent with an oxidation catalyst and oxygen, and contacting the effluent with a dehydrogenation catalyst to convert unreacted alkane to additional quantities of alkene and hydrogen. The Examiner acknowledges that the WO reference fails to disclose adding water to the effluent. The Examiner states that it would have been obvious to modify the WO process with the dehydrogenation effluent of Ward.

Ward discloses a means for increasing conversion in catalytic dehydrogenization processes employing selectivehydrogen combustion. This is achieved by having multibed reaction zones, in which effluent from upstream dehydrogenization beds are cooled, either directly or indirectly, prior to such cooled effluent passing an oxidation

bed. The direct cooling process may utilize the oxygen-containing gas or vaporized water.

The invention, however, does not disclose a method for selecting an optimized cooling method prior to the oxidative heating (selective hydrogen combustion), either direct or indirect, or as a combination of both, but instead is designed to allow a maximum yield of alkene product.

The optimization of such a means for increasing alkene conversion is only possible through a method that maintains control of the coke formation in the catalyst beds. It is known in the art that the dehydrogenation of alkanes leads to significant coke laydown on the catalyst, which deactivates the catalyst over time. Further, it is known that this coke laydown is dependent on the conversion already achieved and on the gas temperature: too high a temperature leads significant coke formation, too low a temperature yields unacceptably low conversion. It is further known that an additional means of controlling coke formation is through the introduction of steam to the process.

In view of the above, the optimization of product yield over time, requires that the coke laydown over different catalyst beds in the series can be controlled such that all of the catalyst beds operate on the same cycle and maintain substantially equal activity over time.

It should be further noted with regard to Ward, that more than 50 to more than 85% of hydrogen entering each oxidation bed shall be consumed by selective combustion, but Ward provides no suggestions or teaching on such optimum hydrogen conversion, as discussed above, while simultaneously controlling coke laydown on the catalyst beds.

To the contrary, the process of the present invention does provide for such a means of optimization. The combination of cooling by both liquid water and steam allows:

Adjustment of the hydrogen combustion to achieve optimum conversion increase by oxidative reheat, while simultaneously controlling maximum temperature achieved by the oxidative reheat thereby adjusting the temperature profile in the various dehydrogenation beds in series with oxidative reheat, and also simultaneously adjusting the optimum steam to hydrocarbon ratio individually in the various dehydrogenation beds in series, allowing the control of coke formation and thereby controlling the activity of the various catalyst beds over the operational cycle.

It is respectfully submitted that one skilled in the art would not look to Ward to combine with the WO reference, and that even if they were such combination would not yield the present invention. One skilled in the art would not be motivated to use the WO reference in conjunction with Ward, and even if combined, would not yield the present invention as claimed herein. Neither of the references teach the combination of steam and water to optimize the process as is done in the present invention.

Additionally, neither of the applied references, and thus no combination of these references, teach the further optimization obtained in that the oxidation and further dehydrogenation may take place in the same catalyst bed and possibly over the same catalyst, which further optimizes the temperature profile, as the endothermic dehydrogenation reaction reduces directly the maximum temperature achieved by oxidative reheat, thus further reducing the coke formation.

In view of the above, it is respectfully submitted that independent claims 10 and 21 distinguish over the applied art of record. Claims 11-20, which depend directly or indirectly from independent claim 11, are believed to be allowable based, at least, upon this dependence.

SUMMARY

It is believed that the above amendments place the application in condition for allowance. Should the Examiner wish to modify the application in any way, applicant's attorney suggests a telephone interview in order to expedite the prosecution of the application.

Respectfully submitted,

A handwritten signature consisting of stylized, overlapping lines and loops, appearing to read "Mark A. Hixon".

Mark A. Hixon
Registration No. 44,766

ATTORNEYS

Marshall & Melhorn, LLC
Four SeaGate - 8th Floor
Toledo, Ohio 43604
(419) 249-7114